

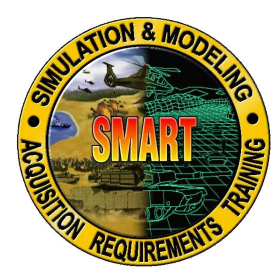
# **Simulation and Modeling for Acquisition, International Test and Evaluation Requirements and Training (SMART)**

**Jim Wallace**

**Alion Science and Technology  
Army Model and Simulation Office  
[James.Wallace@hqda.army.mil](mailto:James.Wallace@hqda.army.mil)**

**Shel Bevan**

**Science Applications Int'l Corp.  
Army Model and Simulation Office  
[Michelle.T.Bevan@saic.com](mailto:Michelle.T.Bevan@saic.com)**



# AGENDA

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## **Section One:**

- Introduction
- M&S Basics
- Policy & Guidance

## **Section Two:**

- SMART
- Simulation Support Plans
- Applying SMART in T&E

## **Section Three:**

- Lessons Learned
- Resources and Information





# ***AGENDA - Section One***

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- *Introduction*
  - *Speaker introductions*
  - *Participant introductions*
- M&S Basics
- Policy & Guidance
- SMART
- Simulation Support Plans
- Applying SMART in T&E
- Lessons Learned
- Resources and Information





# *Introduction*

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## Jim Wallace

Alion Science and Technology, supporting the Battle Command, Simulation and Experimentation Directorate (BCSE), HQDA, DCS G-3, which includes the Army Model and Simulation Office (AMSO). Twenty years active duty military experience in all phases of the systems acquisition life cycle, from requirements analysis to operations & maintenance. Four years experience developing policy and guidance on M&S support to OT&E and Army acquisition programs.

## Shel Bevan

Science Applications International Corporation (SAIC), working in modeling and simulation (M&S) community for 14 years. Formerly with the Modeling and Simulation Information Analysis Center (MSIAC). Background in Verification, Validation and Accreditation (VV&A), Test and Evaluation (T&E), Geography, Space Applications in Research and Development, Instructor and Consultant for M&S.

## Class Participants



# *SMART vs M&S*

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Modeling and Simulation (M&S)

→ Tools, data, algorithms, code

Simulation and Modeling for Acquisition, Requirements and Training (SMART)

→ A concept for applying M&S within a program

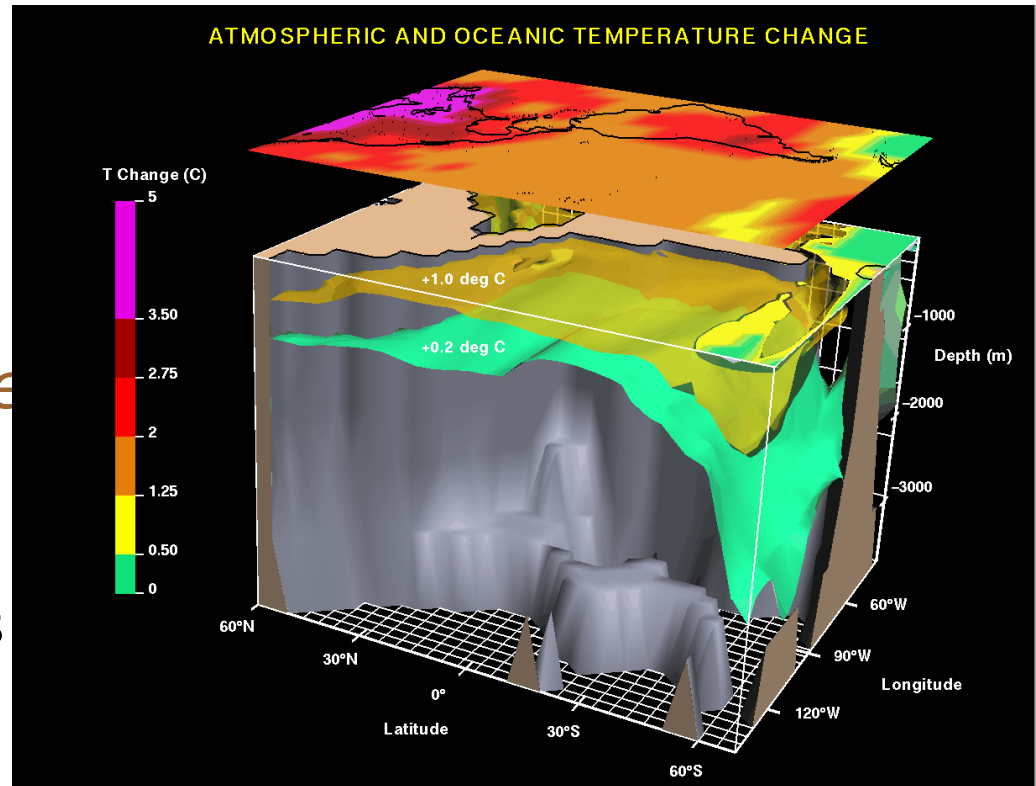
- ✓ Share data, algorithms, & code across functions, phases, & programs
- ✓ Collaboratively develop a strategy to apply M&S
- ✓ Coordinate execution of the M&S strategy

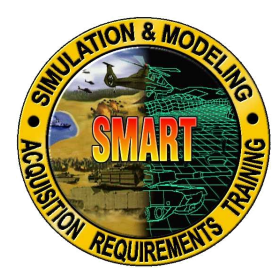
***SMART is the Army process for efficient and effective application of M&S within a program.***



# AGENDA - Section One

- Introduction
- *M&S Basics*
  - *Model, Simulation, Examples*
  - *Benefits, Challenge*
- Policy & Guidance
- SMART
- Simulation Support Plans
- Applying SMART in T&E
- Lessons Learned
- Resources and Information



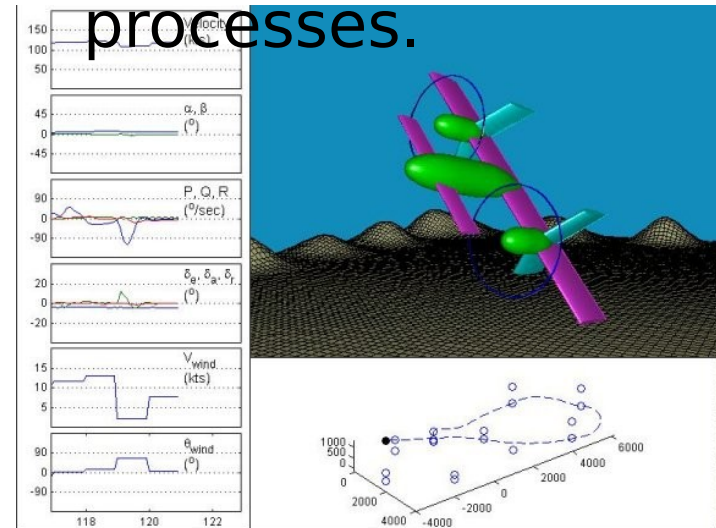


# Models

**Model** - A physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process.

- **Mathematical model** - a series of mathematical equations or relationships that can be discretely solved.
- **Physical model** - a physical representation of a real world object.

**Procedural model** - an expression of dynamic relationships of a situation using math and logical processes.

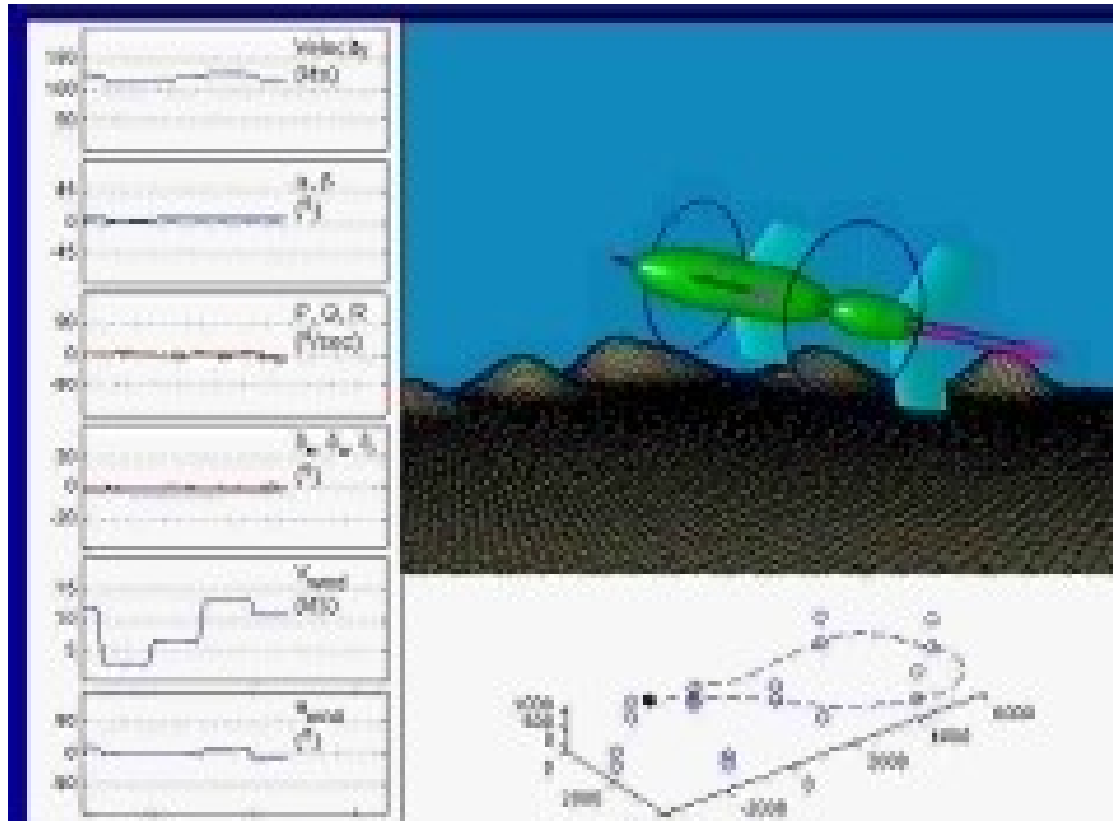


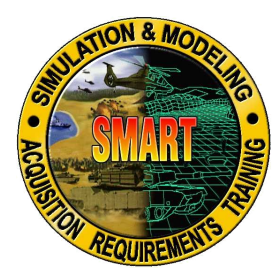


# *Simulati*

*on*

**Simulation** - A method for implementing  
(a) model(s) over time.





# Types of Simulation

## Three Categories of Simulations:

Live (i.e., live fire ranges, maneuver)

Virtual (i.e., UCOFT, CCTT)

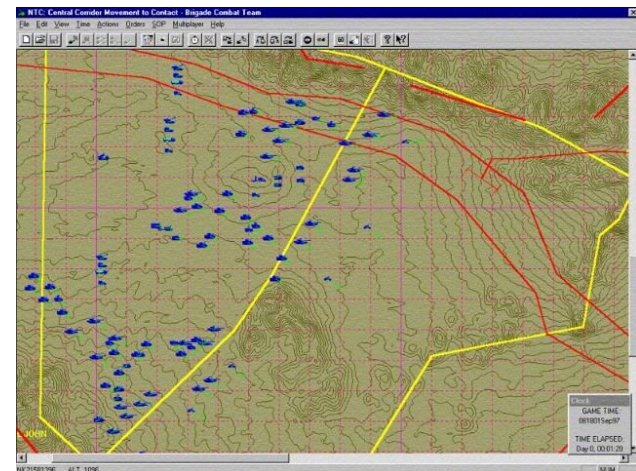
Constructive (i.e., BBS, CBS)



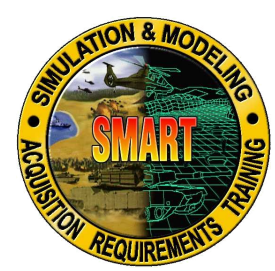
Live Simulation



Virtual (Human In the Loop)

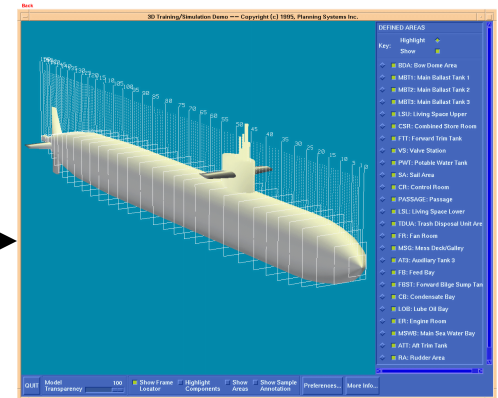


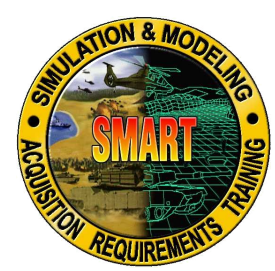
Constructive (Plan View Display)



# *Examples of M&S Use*

- Requirements Evaluation-Janus
- Engineering design-CAD/CAM →
- Tests-STORM (stimulator)
- Training – Army Constructive Training Federation
- Mission Rehearsals-MPARS, CPoF
- Trade-off / Course of Action Analysis-Janus
- Force planning-Janus/OneSAF
- Life cycle cost estimates-ACEIT
- Supportability – COMPASS, ASOAR





# *Challenges to Using M&S*

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- Requirements definition
- Common terrain
- Cost
- M&S development time
- Training effectiveness
- Accuracy of battlefield event representation
- Security
- Representing Total System Life Cycle
- Ability to link and distribute applications
- Embedded training





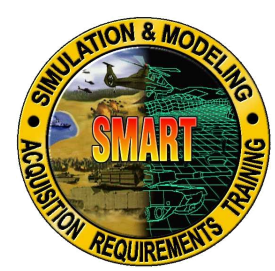
# *Benefits of M&S Use*

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- Allows for robust “what if” analysis
- Prototype multiple alternative designs
- Stimulate hardware-in-the-loop in an operational simulated environment
- Allows for cost effective, realistic training
- Ability to evaluate the plan on-the-move
- Multiple analysis of alternatives
- Determine impact on force structure
- Model and predict true life cycle costs



***BOTTOM LINE: RISK MITIGATION***



# AGENDA - Section One

- Introduction
- M&S Basics
- *Policy & Guidance*
  - *M&S in Requirements & Acquisition*
  - *M&S and T&E*
- SMART
- Simulation Support Plans
- Applying SMART principles
- Lessons Learned
- Resources and Information



# ***M&S and Simulation***

## **Requirements**

**CJCS:** The process to identify capability gaps and potential solutions must be supported by a robust *analytical process which incorporates ... modeling and simulation*. **[CJCSI 3170.01d]**

**Combat Development:** Integrated Concept Teams (ICT) are established to develop concepts, and requirements documentation... The ICT produces the initial [simulation support] *plan for management of simulations*... **[TRADOC Pam 71-9]**

## **Acquisition**

**DoD:** Development and demonstration are aided by the use of *simulation-based acquisition and test and evaluation integrated* into an efficient continuum ... **[DoDI 5000.2]**

**Army:** The MATDEV *plans, manages, documents and communicates the M&S approach* and needs by maintaining a Simulation Support Plan (SSP). **[AR 70-1]** SSP required for all ACAT I, II and non-major systems... **[AR 5-11]**

**Programs:** The *PM articulates his M&S strategy* via the SSP...**[DA Pam 70-3]**

**Advanced Technology Demonstrations:** **[DA Pam 70-3]**

If an ATD includes significant *simulations/simulator support*...a SSP must be

# Army Policy on M&S

## [AR 70-1]

- “Materiel developers (MATDEVs) must develop *a test and simulation strategy* that optimizes the use of appropriate types of events to support the acquisition program.”
- “T&E strategies will *integrate all testing and modeling and simulation (M&S) activities* as an efficient continuum.”
- “*M&S will be an integral part of T&E planning* and will be used to reduce time, resources, and risks involved relative to the T&E programs.”

## [AR 73-1]

- CG, AMC will “*Provide for M&S as it supports the test life cycle*, to include workload, capacity, network, and peak performance tests for C4I/IT systems assigned by DISC4 or USAMC.”
- CG, USATEC will “*Ensure integration of M&S in T&E* to the degree feasible and advance the application of M&S in T&E in accordance with DOD and Army policy.”
- CG, USATEC will “Conduct and/or support the verification, validation, and accreditation (*VV&A*) of all M&S used in T&E and accredit the M&S that are used to support assigned system evaluation.”
- U.S. Army Evaluation Center will “Preview programmed system evaluation requirements for possible *use of M&S to enhance evaluation and reduce costs*.”

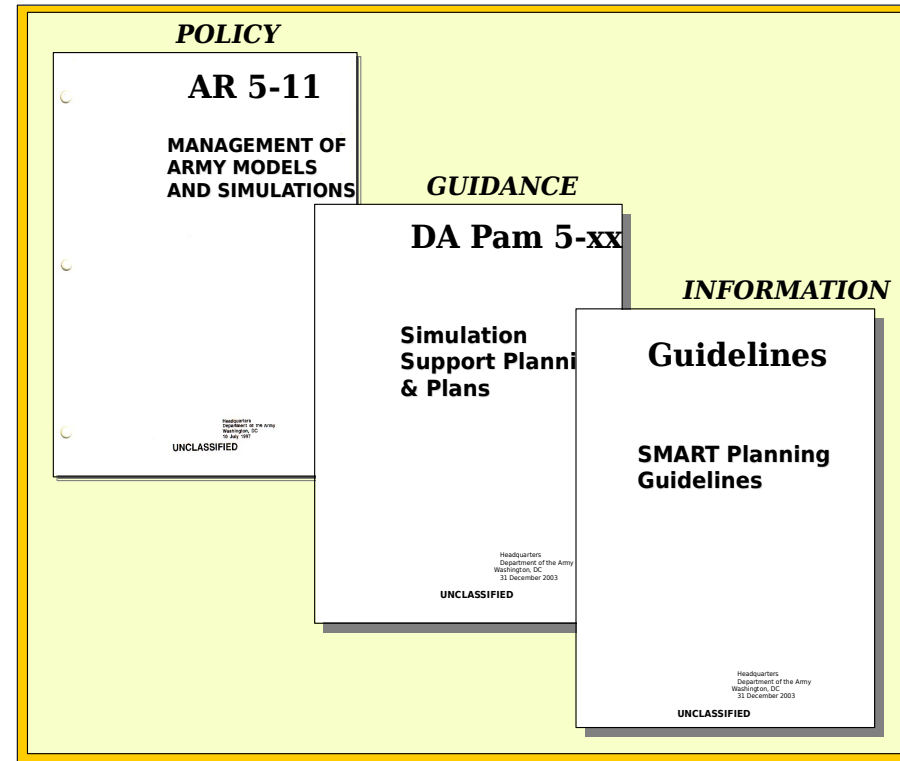


# *SMART and SSP*

## *Policy*

### **SMART Implementation:**

- ❑ **AR 5-11 - being revised to include SMART concept and clarify requirement for SSPs**
- ❑ **DA Pam on Sim Support Planning and Plans:**
  - Detailed requirements for SSPs
  - SSP Proponent
  - SSP development, format & content
  - CDD to SSP crosswalk
  - Authoritative System Representation
- ❑ **SMART Planning Guidelines**
  - Sep 02, Appendix C revised - SSP management, form & content
  - Future update after draft DA Pam 5-xx published





# Documenting M&S Use

- **Interim Def Acq Guidebook (DoD 5000.2-R)**
  - The PM shall describe, in *the acquisition strategy*, the planned implementation of SBA/M&S throughout program development, ... and in developmental, operational and live fire testing applications.
  - “[The *TEMP*] shall provide a road map for integrated simulation, test, and evaluation plans, schedules, and resource requirements necessary to accomplish the T&E program.”
- **AR 70-1**
  - “The MATDEV plans, manages, documents and communicates the M&S approach and needs by maintaining a *Simulation Support Plan* (SSP)”
- **AR 5-11**
  - “A *simulation support plan* will be developed [for all ACAT I, ACAT II and non-major programs].”
  - “The *SSP* is the vehicle to effectively manage and integrate the use of M&S in our acquisition process.” [SAAL-DO policy memo]
- **AR 73-1**
  - The System Evaluation Plan (SEP) documents the evaluation strategy and overall test/*simulation execution strategy* (T/SES).



# AGENDA - Section Two

- Introduction
- M&S Basics
- Policy & Guidance
- *SMART*
  - *Definition*
  - *History*
  - *Key Tenets*
- Simulation Support Plans
- Applying SMART in T&E
- Lessons Learned
- Resources and Information





# *What is SMART?*

**SMART is a change in Army business practices, through the exploitation of M&S and other information age technologies to facilitate collaboration and synchronization of effort across the total life cycle of Army systems.**

- **SMART is NOT a program, it is a cradle-to-grave “business model”**
  - Concept analysis, development, testing, training, and sustainment efforts will leverage M&S across the system life cycle.
- **SMART is about a change in Army acquisition practices**
  - Simulation support planning is conducted to determine how M&S can be used to reduce risk, cost and schedule.
- **SMART is about cross-functional, collaborative use of M&S**
  - The PM develops an M&S strategy that is integrated with and supports the overall acquisition strategy.
- **SMART is about leveraging success and reusing Army M&S resources**

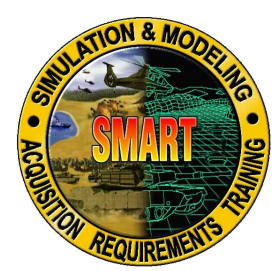


# SMART

## Genesis

### Army extended the SBA concept to *Simulation and Modeling for Acquisition, Requirements and Training (SMART)*

- **SBA**: An Acquisition Process in which DoD and industry are enabled by robust, collaborative use of simulation technology that is integrated *across acquisition phases and programs*. **[SBA Roadmap]**
- **SMART**: Army SMART concept extends SBA to include the collaborative use of M&S across organizational and functional areas (analysis, systems engineering, test and evaluation, training and logistics). The SMART concept is that M&S can be integrated *through-out the system lifecycle, across M&S domains, acquisition phases, and programs*.



# SMART History

**2000...SMART  
Guidance  
published**

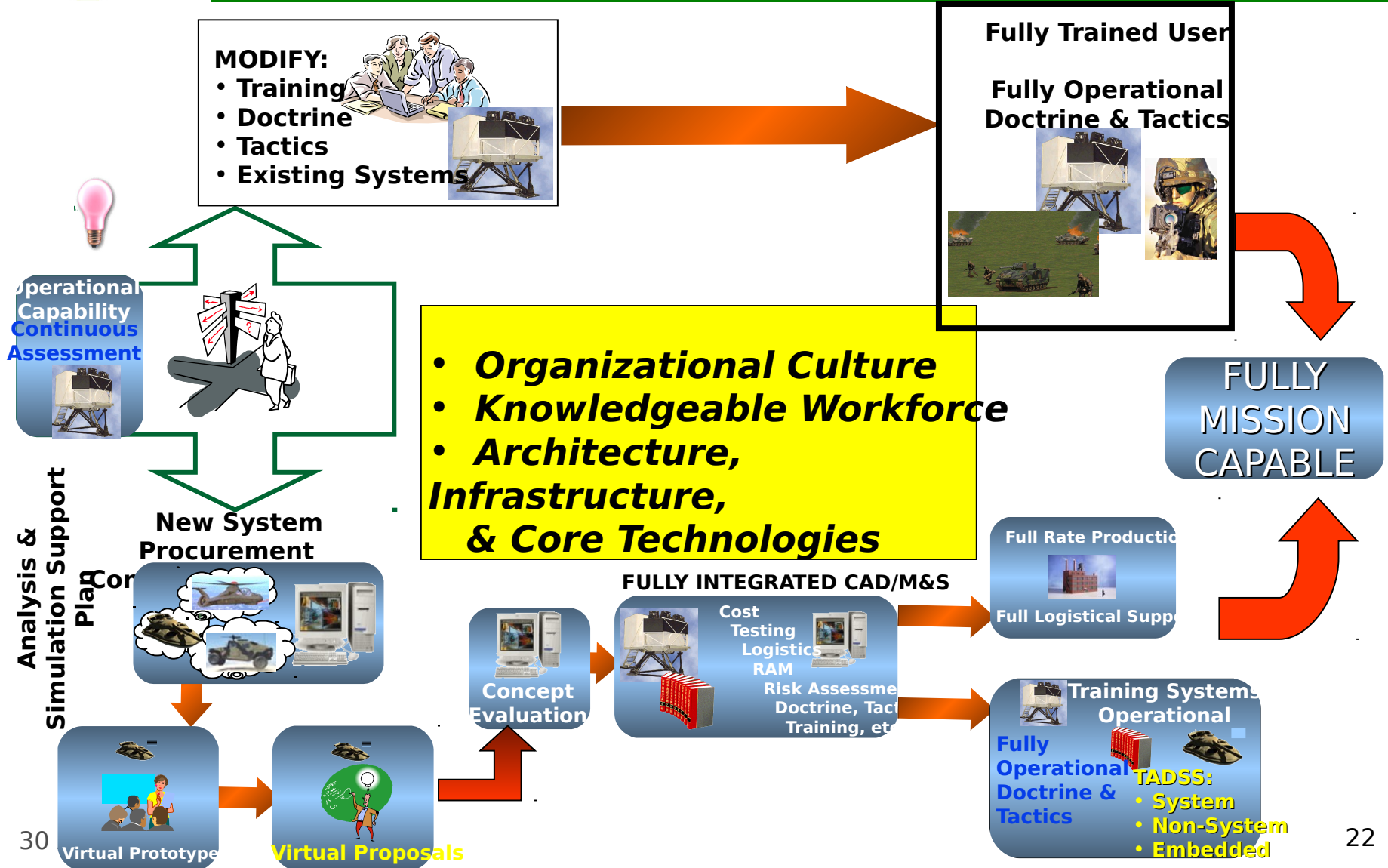
**“The Planning Guidelines...  
were developed to address  
growing robustness of SMART as it became the  
new paradigm for conducting acquisition and  
addressing a system’s M&S needs throughout the  
life cycle of the system.”**



**In Executive Summary, Planning Guidelines for Simulation and Modeling  
for Acquisition, Requirements and Training, September, 2000**



# SMART Concept





# *SMART*

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## *Tenets*

### **1. Plan for Simulation Support**

- Continuous, collaborative, coordinated and documented

→ *KEY to successful implementation of SMART*

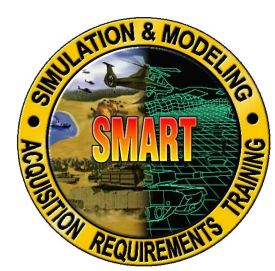
### **2. Advanced Collaborative Environment**

- Shared environment includes interoperable tools, databases and product/process models

### **3. Authoritative System Representation**

- PM-approved description of a system's performance, behavior, and operation in the intended environment

### **4. Model & Simulation Reuse**



# *SMART Tenet*

## **#1**

## **Simulation Support Planning**

- **Needs to be**
  - **Continuous throughout the system life cycle**
  - **Collaborative across domains & phases**
  - **Coordinated with key stakeholders**
  - **Documented (Simulation Support Plan)**
- **Should begin early**
  - **During Concept Refinement**





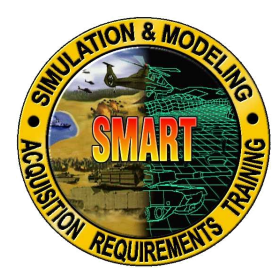
# *SMART Tenet #2*

## **Advanced Collaborative Environment (ACE):**

*(Within a SMART context)*

- **Is a shared environment that facilitates an enduring collection of subject matter experts (SMEs) that are focused on a common domain or set of problems.**
- **Includes interoperable tools, databases and product/process models**
- **Is supported by diverse information sources.**





# *SMART Tenet #3*

## **Authoritative System Representation (ASR)**

- **PM-approved description of a system's**
  - **performance**
  - **behavior**
  - **operation in the intended environment.**
- **Facilitates modeling and simulation of the system and its interactions in the intended environment.**





# *SMART Tenet*

## **#4**

## **Model and Simulation Reuse**

- **Reuse of conceptual models, algorithms and code**
    - **Efficient acquisition of M&S knowledge and engineering**
    - **Across programs, phases, functions,**
    - **Repositories:**
      - Army**     <http://www.msrr.army.mil/>
      - DoD**     <http://www.msrr.dmsso.mil/>
  - **Standards represent cross-domain consensus on M&S algorithms, heuristics, and procedures.**
- Why Standards ?**
- **Minimize M&S costs**
  - **Compatibility with other simulations**
  - **Consistency & interoperability among simulations**



# ***AGENDA - Section***

## ***Two***

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- Introduction
- M&S Basics
- M&S Policy and Guidance
- SMART
- *Simulation Support Plans*
  - *SSP Policy & Guidance*
  - *Simulation Support Planning for T&E*
- Applying SMART in T&E
- Lessons Learned
- Resources and Information



# *Simulation Support Plan (SSP)*

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## *SSP*

### *Definition*

The Simulation Support Plan (SSP) is the plan for utilization of M&S over the lifecycle of a system, or system of systems, from concept and technology development to disposal/system retirement. The SSP will address how SMART is being used to support Army business processes. The SSP is a document that evolves as the system matures.



# *The SSP is a SMART Enabler*

## **SMART is documented by the SSP**

- **How SMART (tenets) will be implemented.**
- **An M&S strategy that describes the planned use of M&S as part of the overall acquisition strategy.**

*An SSP depicts the how and when M&S tools are integrated, utilized and transitioned in the course of concept exploration and system development. [AR 70-1, DA Pam 5-xx]*



# *SSP Policy*

**“A simulation support plan will be developed according to SARD Policy memo...” [AR 5-11]**

**“The Simulation Support Plan (SSP), [is] required for all ACAT I, ACAT II and non-major system programs... the M&S support plan will be coordinated with the appropriate support agencies and included in the Program's Acquisition Strategy...” [SARD Policy memo dated 20 September 1996]**

**Army has *required* SSPs since 1996.**



# *SSP History*

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1996: SAAL: SSPs required

1997: SSP Guidelines

2000: SMART Planning Guidelines

2000: SMART Execution Plan

2001: TRADOC: SSPs part of ICT  
process

2002: AMSO added as AROC Advisor

2003: TRADOC: Rqmts docs require

***Simulation Support Plans are being  
used today to support decisions  
about Army programs.***



# SSP

## Objectives

***Provide Combat Developers, Materiel Developers and Training Developers with a management tool that enables better use of M&S and improves program implementation and effectiveness.***

1. Identify, validate, and program M&S investments.
2. Identify models used and upgrades needed. This is important if an Enterprise level model such as OneSAF must be upgraded.
3. Ensure adherence to best practices and approved standards (or help to identify places where new standards would be of use).
4. Assist with cross domain coordination.
5. Encourage peer review and incorporation of lessons learned.
6. Ensure adequate Validation, Verification, and Accreditation (VV&A).
7. Ensure effective use of Army Subject Matter Experts (SME), data, & models.
8. Ensure S&T (and other efforts) have data/model generation as part of output.
9. Find and eliminate duplication of effort.



# ***Simulation Support Plan (SSP)***

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- **The SSP is a program management tool.**
- **Developing an SSP early helps to identify issues/concerns for early resolution.**
- **SSP development should include all key stakeholders to ensure “buy-in” and support of the M&S strategy.**
- **Having an SSP does not mean that the PM must develop a simulation of the system.**
- **As a minimum, every SSP should address:**
  - a. **M&S used to address interoperability issues.**
  - b. **M&S used to address life cycle cost.**
  - c. **M&S used to address system performance data.**
  - d. **M&S used to perform T&E.**
  - e. **M&S used to support training.**



# *SSP*

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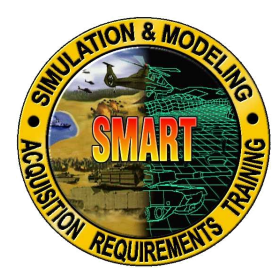
# *Development*

“The MATDEV will include M&S in the integrated product and process development (IPPD) to plan for early and disciplined integration of M&S that supports program design.” **[AR 70-1]**

“The preferred method for a PM to develop and/or update the SSP is through an M&S Integrated Product Team (IPT) comprised of representatives from Army agencies that are key stakeholders for the system being developed.”

**[DA Pam 5-xx]**

***Involving a team helps you cover all the bases.***



# SSP

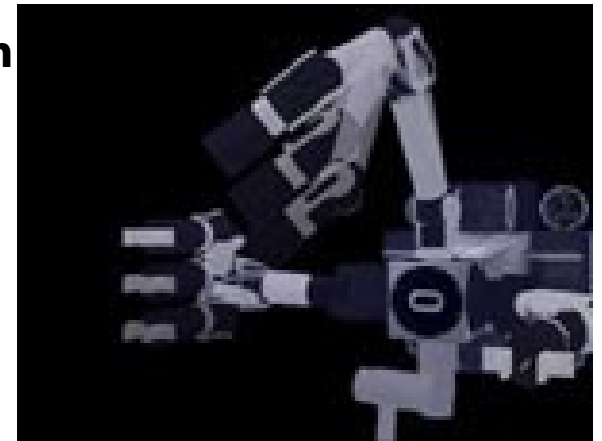
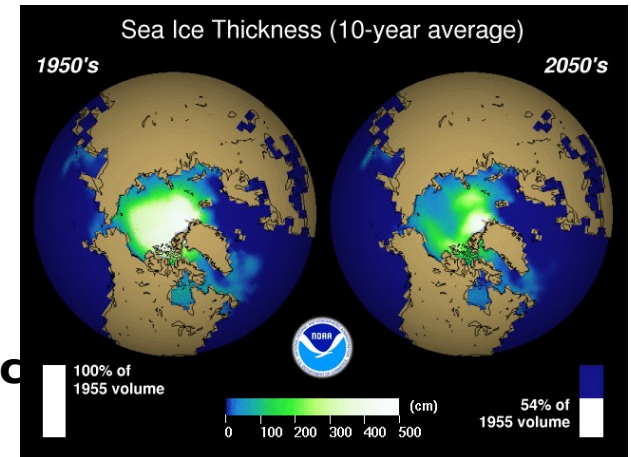
## Format

### Title Page

### Approval and Coordination Summary

### Table of Contents

1. **Purpose**
  2. **Executive Summary**
  3. **System Description Overview**
  4. **System Acquisition Strategy**
  5. **Model and Simulation Support Approach**
    - 5.1 M&S Strategy
    - 5.2 Life cycle Use of M&S
    - 5.3 Capabilities Document Crosswalk with M&S
    - 5.4 Interoperability
  6. **Authoritative System Representation**
  7. **Management of M&S Resources**
    - 7.1 Management Organization
    - 7.2 Resources and Cost
    - 7.3 Data Sources
- Appendices:**
- A. References
  - B. Acronyms
  - C. Definitions
  - D. Descriptions of Models, Simulations & Other Simulation Support Tools





# *SSP Describes M&S*

## *~~Support to T&E~~*

1. How does M&S assist in carrying out the system's test and evaluation program in each functional area and phase?
2. Is M&S used to facilitate developmental testing?
3. Is M&S used to facilitate operational testing?
4. How is M&S used to facilitate live fire test and evaluation?
5. How will M&S be used to verify interoperability requirements?
6. How will M&S be used to represent the expected Operational Environment?
7. Is the use of M&S in test and evaluation cost and time effective?
8. Has a “model-test-model” process been set up or defined?
9. If appropriate, is the Simulation Test and Evaluation Program (STEP) process used in developing the strategy for test and evaluation?
10. Has the SSP been crosswalked with the TEMP?
11. Have the models and simulations used for T&E been considered for use in Training for the system?



# *SSP*

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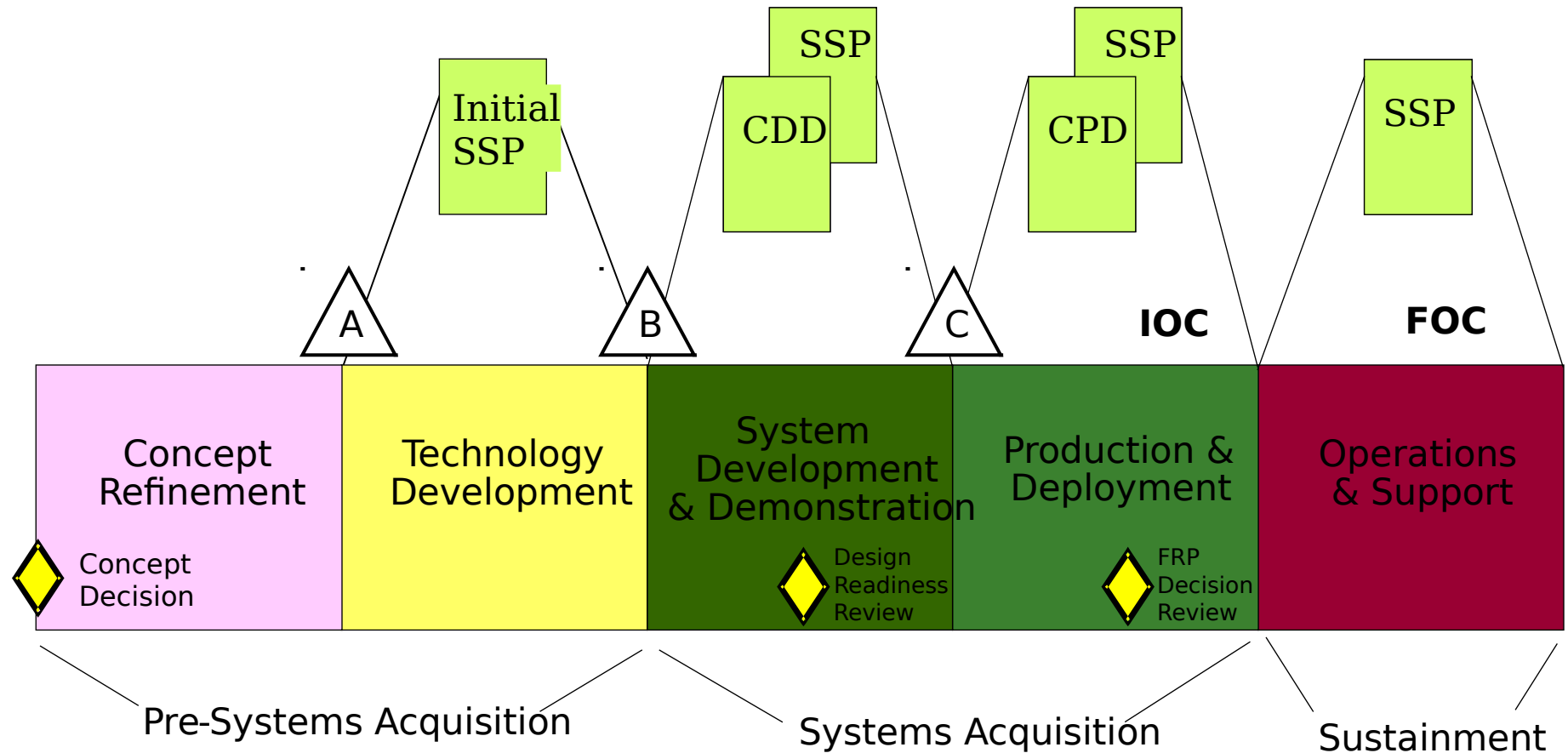
## *Coordination*

- **Catch duplication**
- **Identify M&S investment needs**
- **Adherence to best practices**
- **Identify models used or required upgrades**
- **Identify adherence to approved standards (or to help identify places where new standards would be of use)**
- **Assist with cross domain coordination**
- **Allow for peer review/incorporation of lessons learned**
- **Ensure adequate VV&A**
- **Ensure effective use of Army SMEs (data/models)**
- **Ensure S&T (and other efforts) have**





# *SSPs in the Acquisition* *~~LifeCycle~~*





# SMART

## Management

**Simulation  
Support  
Planning**

**Develop  
Review  
Coordinate  
M&S strategy**



STRAP

CDD

TEMP

Acq  
Strateg  
y

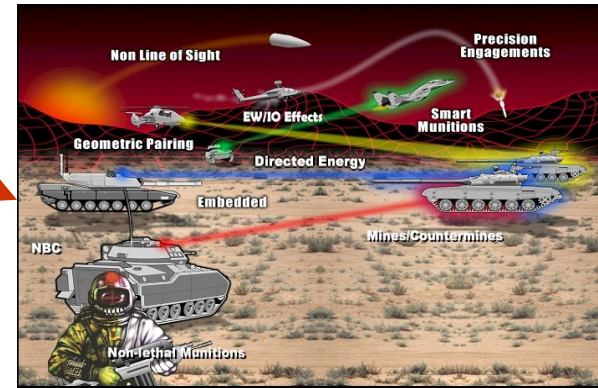
**Supports**

**SSP**

**"M&S Strategy"**

**Execute the  
M&S strategy**

**IAW  
CJCS 3170  
DoD 5000  
AR 70-1  
AR 5-11**



**M&S capability**



# AGENDA - Section Two

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- Introduction
- M&S Basics
- SMART
- Policy & Guidance
- Simulation Support Plans
- *Applying SMART in T&E*
  - *M&S use in T&E (planning, rehearsal, augment test information, scenario gen, SoS testing)*
  - *STEP*
  - *VV&A*
- Lessons Learned
- Resources and Information





# ***Role of M&S in T&E***

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**The PM, in concert with the user and test and evaluation communities, shall coordinate DT&E, OT&E, LFT&E, family-of-systems interoperability testing, information assurance testing, and M&S activities, into *an efficient continuum*. [DoDI 5000.2]**

**“SBA/M&S shall support efficient test *planning*; pre-test results *prediction*; *validation* of system interoperability; and shall supplement design *qualification*, *actual T&E*, manufacturing, and operational support.” [DoD 5000.2-R]**



# *Role of M&S in OT&E*

...we must continue to focus on, "...the real system, in the real environment, with the real operator..."

...I believe the notion of replacing testing with M&S simulation is inappropriate.

**...however...**

- Models should help us predict performance throughout the mission space.
- Models should help us design tests to maximize our learning and optimally apply our resources.
- Models (stimulators) should help us replicate the environment during test to realistically stress the system under test.
- Model should add to our insight and understanding in interpreting collected data.
- Models using data and information gleaned from testing should be used to demonstrate the significance of conclusions reached.

**Thomas P. Christie**

**Director, Operational Test and  
Evaluation**

**Memo, 4 June 2002**



# *Identification of M&S Needs*

## *Selection of M&S Tools*

**1 of 3**

- Coupled with selection of live test events.
- Ensure approach to execute evaluation strategy is most cost-effective.
- Need to validate data sources.
- Live tests
  - ✓ Verified for efficient and effective design
  - ✓ Validated to ensure that environmental conditions are appropriate and sufficient, and that specific issues (information voids) are adequately addressed.
- M&S
  - ✓ Verified for logical stepwise process and use of sound software engineering techniques;
  - ✓ Validated for output, relative to input, that is comparable to real world observations; and officially accepted (accredited) as a source of credible data for a specific application.



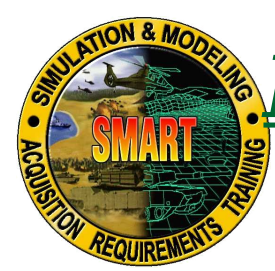
# *Identification of M&S Needs*

## *Selection of M&S Tools*

- Uses of M&S in T&E **2 of 3**
  - ✓ Pure simulation (computer testing a model of a system),
  - ✓ Man-in-the-loop simulation, live (hardware) testing supported by simulation,
  - ✓ Simulation supported by live test data.

Questions to consider:

- 1. What M&S are available to provide insight into how the new system might affect the mission?**
  - Models that reflect system performance characteristics
  - Models of threat systems
  - Combat models that are sensitive to modeled system performance characteristics
  - Synthetic stimuli and environments that influence modeled system performance characteristics.
- 2. What evaluation questions need to be answered?**
- 3. What M&S, including threat M&S, can be used to extend the analysis of available data, or of data from planned live tests?**



# *Identification of M&S Needs*

## *Selection of M&S Tools*

Questions to Consider (continued):

**3 of  
3**

4. What are the limitations of the live test events we must perform,  
that may be overcome through the use of M&S?
5. What well-understood aspects of the system's performance  
might be modeled, to focus testing on unknown aspects?
6. What are the verification and validation (V&V) requirements  
the system must meet?
7. What test models are needed to validate the system?
8. What M&S tools are needed to support these live test events?





# *Identification of M&S Needs*

## *Selection of M&S Tools*

---

**1 of 2**

- M&S selection will include consideration of the following:
  - Output relates directly to required MOE and MOP.
  - Inputs are known, or readily available from testing or other sources.
  - Required assumptions are known, valid, credible, and defensible.
  - M&S are compatible with available computer platforms, system stimulators, hardware/human-in-the-loop simulators, and other models with which it will interact.
  - M&S can be modified at a cost, if necessary, to meet acceptability criteria.
  - M&S selected is consistent with those used, or is acceptable for reuse, elsewhere in acquisition process (concept exploration, design, manufacture, training, and maintenance).



# *Identification of M&S Needs*

## *Selection of M&S Tools*

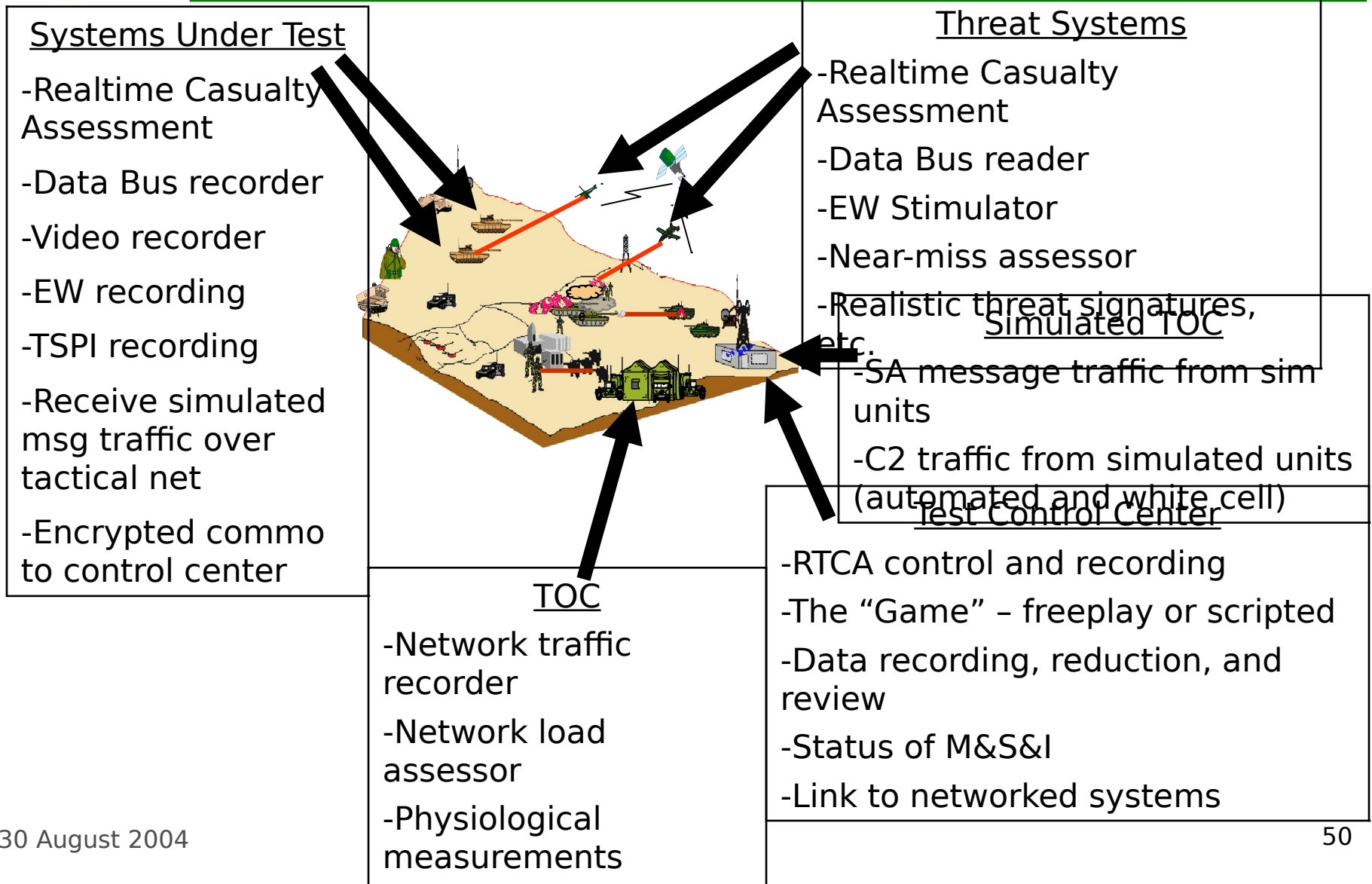
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**2 of 2**

- M&S selection will include consideration of the following (continued):
  - M&S present output data in a way that facilitates the evaluation process.
  - M&S provide relevant, realistic, controllable, repeatable, affordable synthetic environment or stimulus.
  - Use of the M&S reduces the time or cost of a live test event.
  - Government has data rights to model.
  - Degree to which the M&S have undergone V&V, or are sufficiently documented to allow affordable V&V and accreditation with minimal live testing.



# Support To Complex Operational T





# History of Simulation Use in OT

## 1980's

1983

- TACSIM for MSE

1989

- TACSIM-OT for ASAS
- CBS/SSM & CATS for MCS/ASAS/AFATDS



## 1990's

1993

- FSATS for AFATDS

1994

- CEES for FAAD-C2I

1995

- Mobile FMS for PAC3 LUT

1999

- TMDSE for PAC3

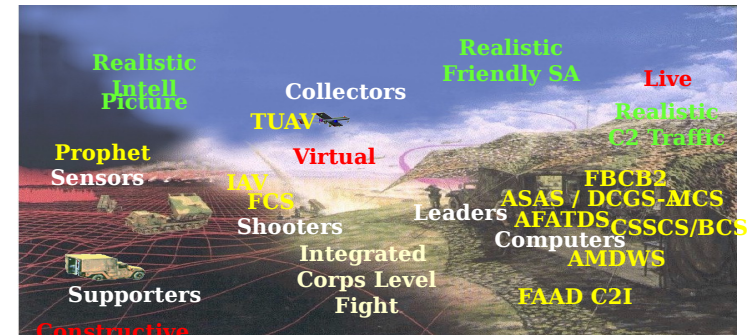


## Early 2000's



- Janus & STORM for FBCB2
- MAIS (now OT-TES) for Canadian LAV evaluation
- Janus/EADSIM/MAIS for TUAV
- Janus/STORM/EADSIM for Stryker OE and IOT

## Future

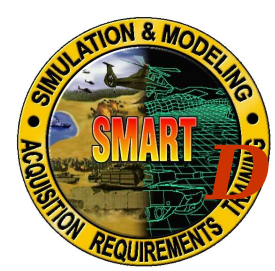


**Network-centric testing  
System-of-systems (SoS) testing**



# *Identification of M&S Needs* *The Evaluation Planning Process*

- M&S and tests are mutually supportive rather than competing, isolated, or duplicative.
- The ATEC System Team (AST), in collaboration with the T&E Working Integrated Process Team (T&E WIPT), is the forum for developing the system-level T&E strategy. Based on requirements identified in:
  - Capabilities Development Document (CDD – formerly ORD)
  - Critical Operational Issues and Criteria (COIC),
  - Supporting documents such as the Test and Evaluation Master Plan (TEMP), Analysis of Alternatives (AoA), Simulation Support Plan (SSP), threat assessments, and mission area strategies
- The T&E section of the SSP, and the M&S section of the TEMP must reflect the results of M&S planning for T&E



# *Identification of M&S Needs*

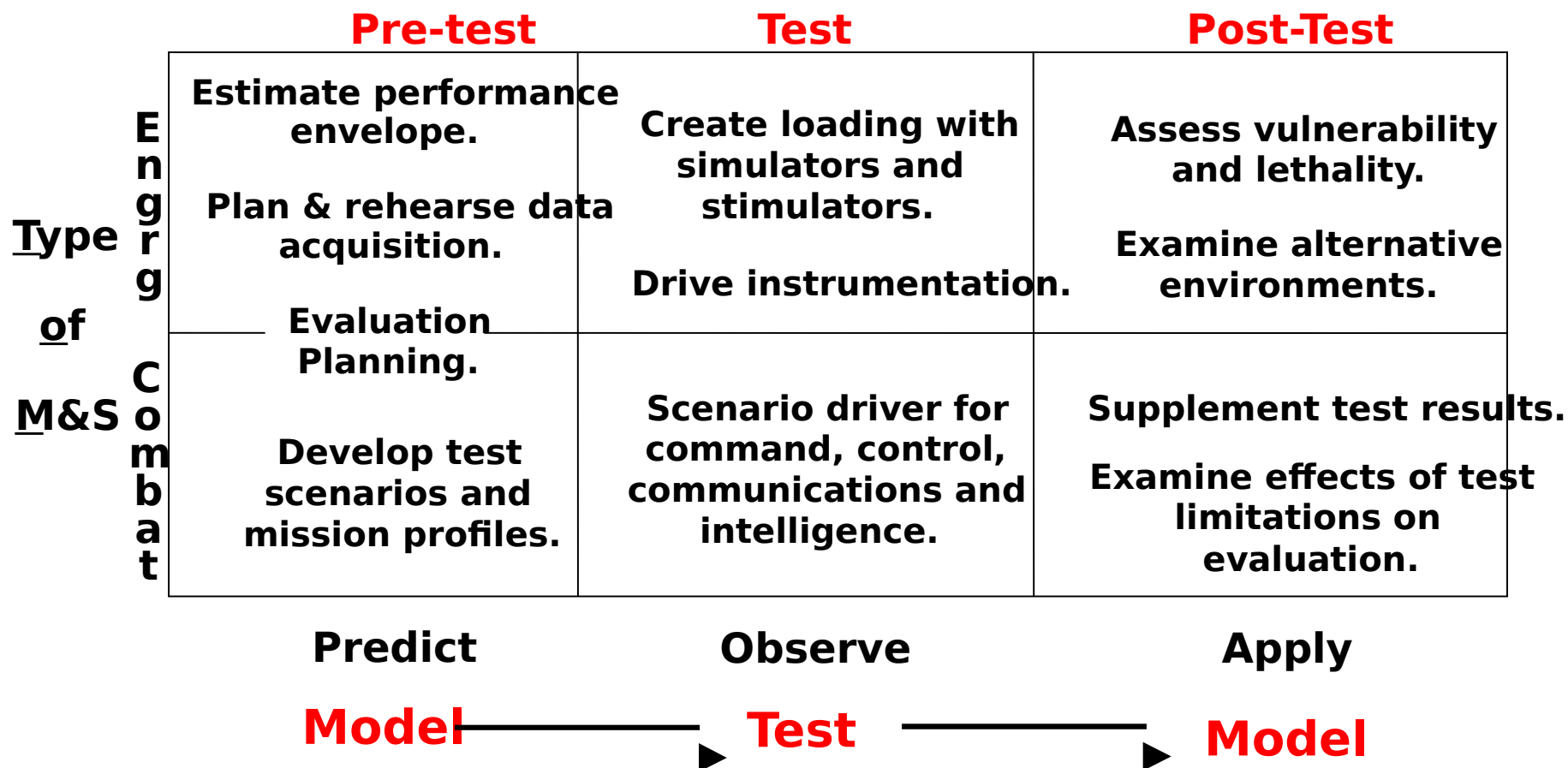
## *Drafting the System Evaluation Plan (SEP)*

- Examine requirements documents to identify aspects of system capabilities essential for mission accomplishment.
- Establish measures of effectiveness (MOE) and measures of performance (MOP) to quantify the needed capabilities.
- Identify existing sources and planned activities, within the PM's acquisition strategy, that can provide data for the measures.
- Propose dedicated events to generate required data to fill information voids.
- Sequence and optimize those events to focus on the specific, relevant unknowns.
- Develop the data source matrix (DSM).
- Coordinate the draft SEP with the T&E WIPT to ensure that all credible, relevant data sources are considered throughout the acquisition, and that all issues for the system evaluation are addressed progressively.



# *Using M&S Results in Evaluation*

## M&S Applications





# *M&S&I for SoS* *OT*

---

## ***Modeling & Simulation & Instrumentation for SoS OT***

- Environment must be realistic
  - High-fidelity
  - Interactive (short of freeplay)
  - Real time (one-for-one)
  - TRADOC Defense Planning Guidance derived scenarios
  - Appropriate Threat
  - Maximize non-interference with Soldiers and systems under test
- Simulation must be accredited for each specific use
  - Past VV&A work provides a basis for accreditation for specific test
  - Simulation must add all that's expected and must respond accurately
  - May require a dedicated mini-test - IMASE-ISSS V&V required 5-8 personnel, 50 manweeks (\$98K)



# Accomplished Through Teaming

---

- RTCA/TESS – OT-TES/OneTESS
  - ❑ ATEC - Operational Test Command (OTC)
  - ❑ TRADOC – Army Training Support Center (ATSC), National Training Center (NTC)
  - ❑ PEO STRI - PM ITTS
  - ❑ PM Future Combat Systems (FCS)
- STORM
  - ❑ RDECOM - CERDEC
  - ❑ TRADOC - TRAC-WSMR, National Simulation Center, TRADOC System Managers
  - ❑ DTC – Electronic Proving Ground (EPG)
  - ❑ JFCOM for JCATS changes to support STORM enhancements
- ROCS & VETT (Realistic Operational Communications Scenario & Voice/Video Emulation Test Tool) – Marines, OTC
- IMASE
  - ❑ PEO STRI – Threat Simulation Management Office (TSMO)
  - ❑ ATEC – OTC
  - ❑ DA - G2
  - ❑ PM FCS - Lead Systems Integrator (LSI)

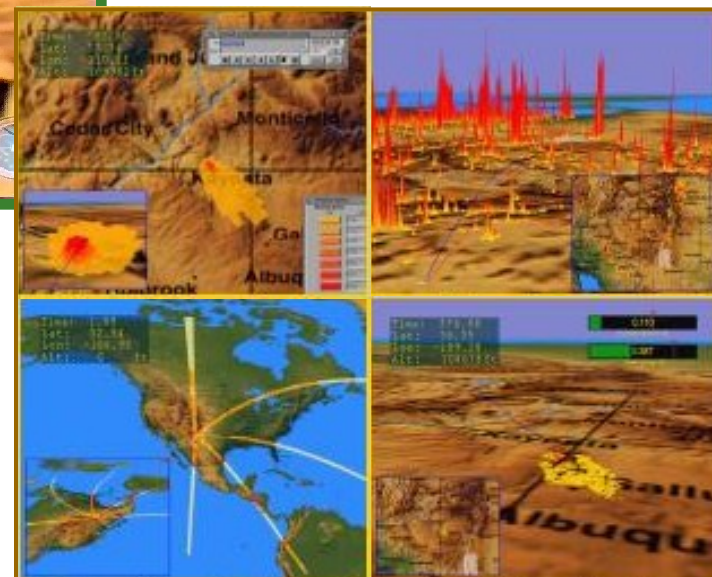
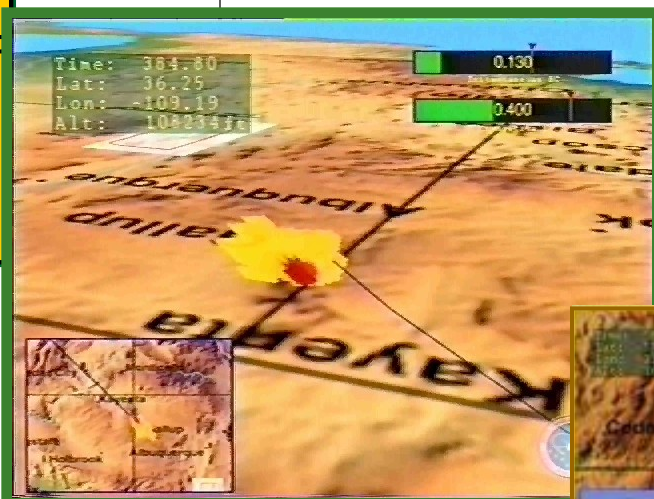


# M&S Tools

## VPG Tools

**Mission Planning, Real-time Test Analysis, Flight Safety Analysis, etc.**

**Distributed Test Control  
Test Planning  
Visualization  
etc.**



## Features:

- Risk and hazard visualization
- Population density visualization
- Trajectory, corridor, overshoot planning
- Supported several programs including NASA's X-34
- System delivered to Range Operations Flight Safety Division

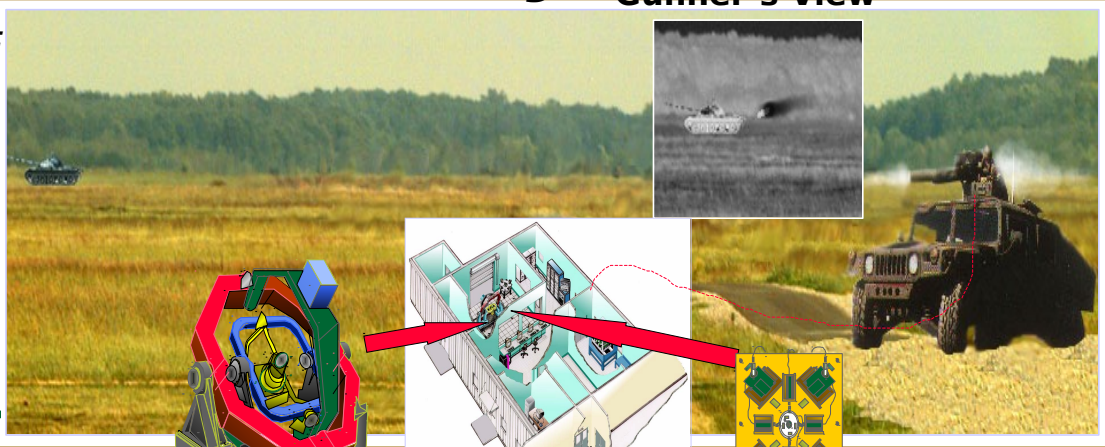


# Synthetic Environments

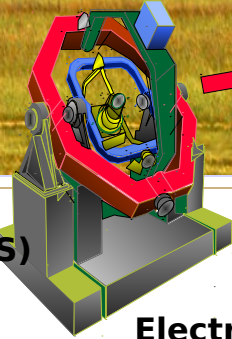
## Air Defense Missile Flight Environment



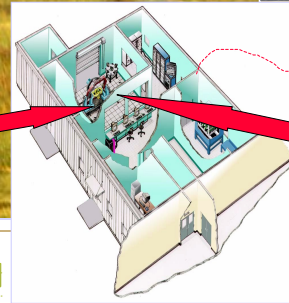
## Virtual Range Gunner's View



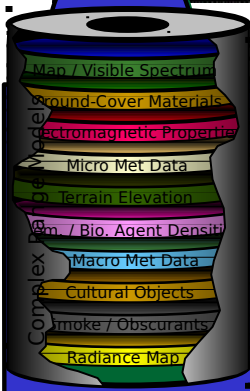
## Flight Motion Simulator (FMS)



## Electro-Optical Sensor Flight Evaluation Laboratory (EOSFEL)

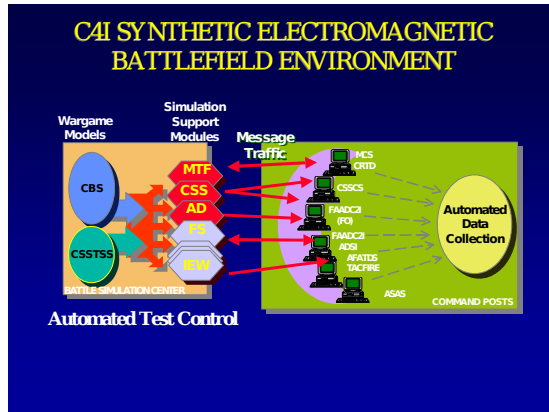
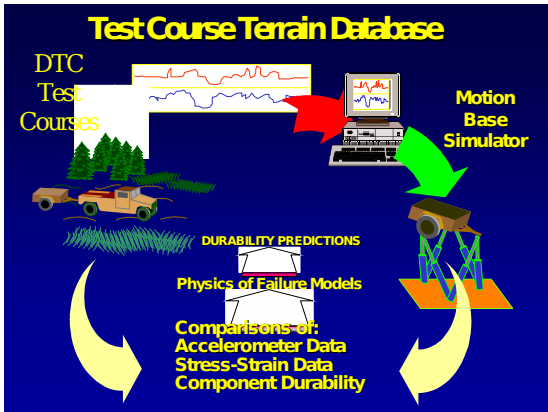


## Dynamic Fin Loader (DFL)



## Ranges

## Complex Synthetic Test Environments



- CommC2 Networks
- Force Role Players
- GPS Translocation



**EPG**

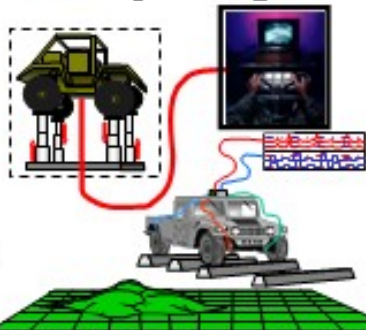
**DPG**

- Live Sensor
- Simulated Chemical Threat
- Weather



**ATC**

- Robotic Intelligence
- Mobility Modeling

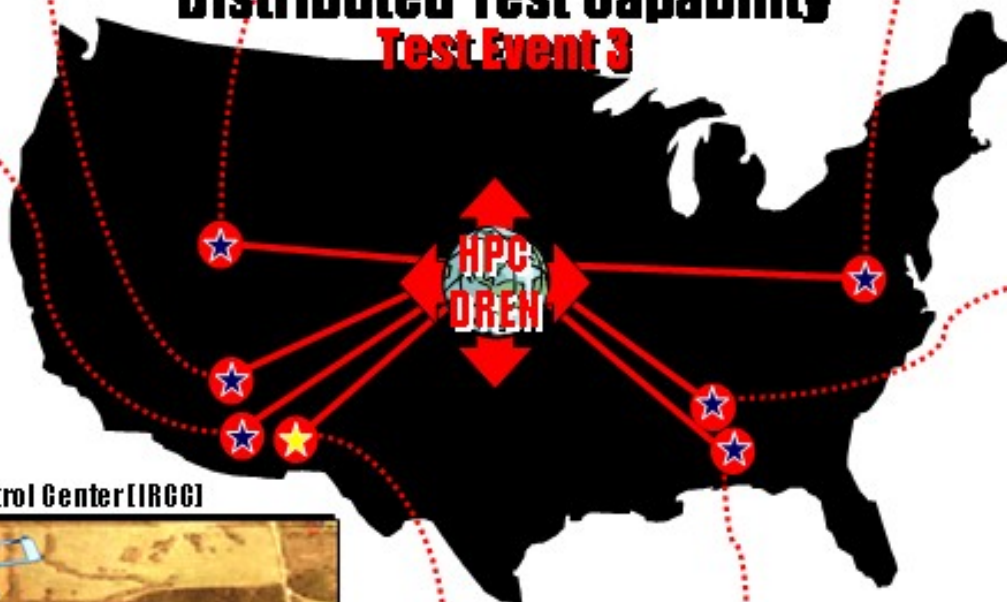


**YPG**

- Test Site
- Digital Terrain
- Precision Cargo Drop



## Distributed Test Capability Test Event 3



**RTTC**

- IR Sensor Vehicle Roles
- Human Operators
- Live Sensors
- OTB



Inter-Range Control Center (IRCC)



**WSMR**

**ATTC**

- IR Sensor Air Vehicle
- Human Operator
- Live Sensor

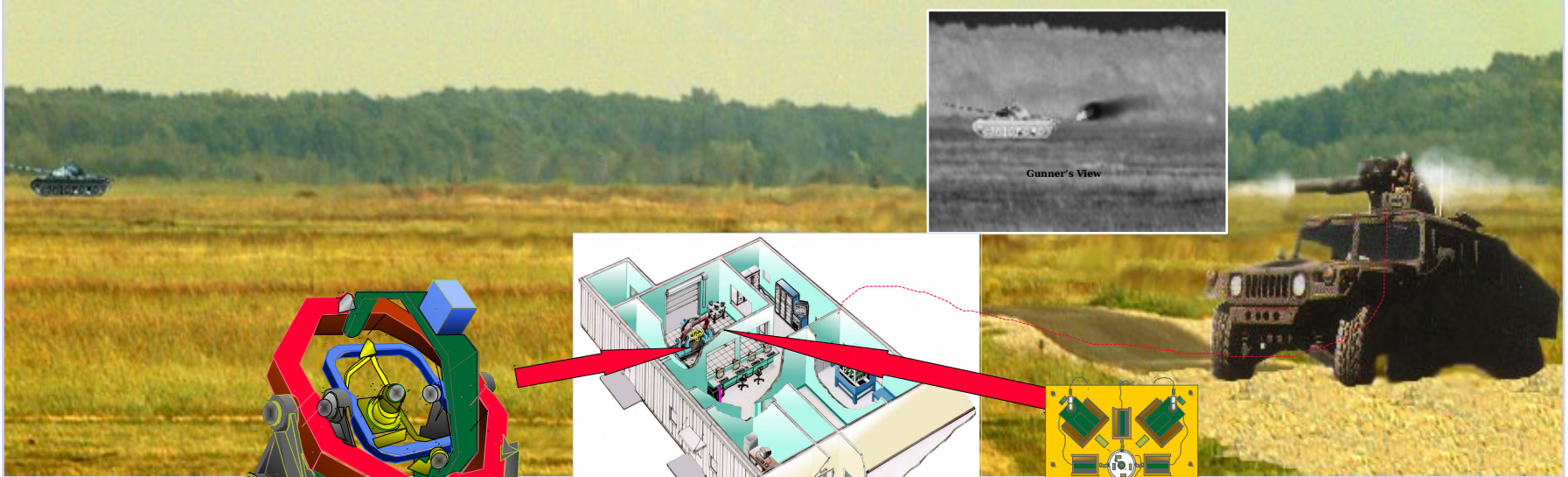


- Event control/Central Viewing
- Live Fixed Wing
- Surrogate TOC
- White Cell
- Janus wraparound



# M&S Integration with Testing (Create System Loading)

*Electro-Optical Sensor Flight Evaluation Laboratory*



**Flight Motion Simulator (FMS)**

**Electro-Optical Sensor Flight Evaluation Laboratory (EOSFEL)**

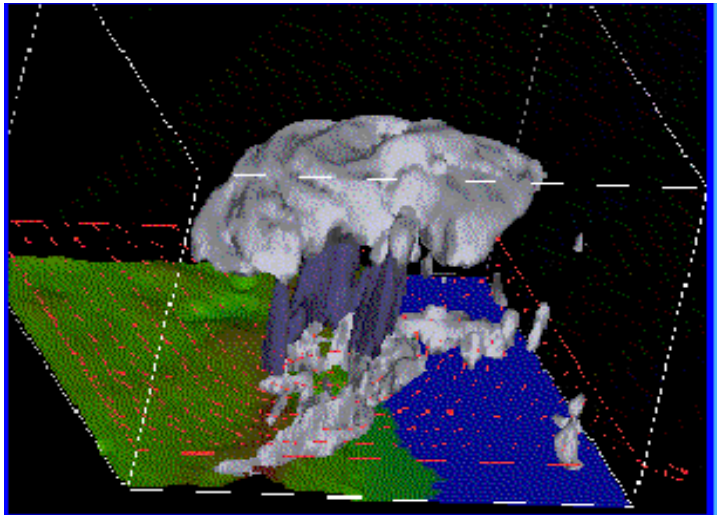
**Dynamic Fin Loader (DFL)**

Infrared-seeking tactical missiles are immersed in synthetic flight environments to exercise the entire missile seeker/guidance and control system and sub-system. The hardware-in-the-loop facility presents dynamic IR scenes that include target signature and motion, terrain features, natural and man-made obscuration and foliage to the seeker. The missile airframe “flies” in a 6 degree of freedom (6 DOF) fixture that provides climatic conditioning, dynamically loads its control surfaces to simulate aerodynamic forces, while instrumentation feeds back flight

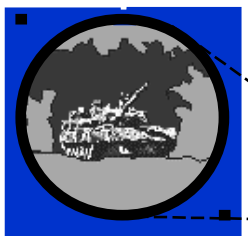


# *M&S Integration with Testing (Examine Alternative Environments)*

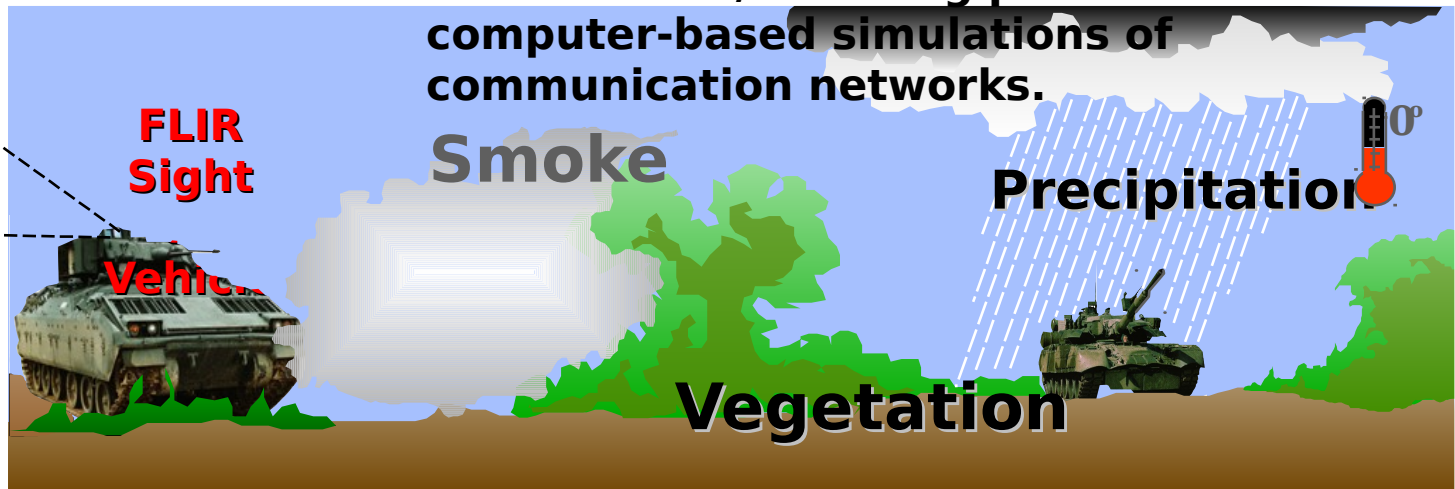
## *ATMOSPHERIC EFFECTS MODELING*



**Atmospheric Effects Modeling provides the tools to synthesize atmospheric effects that can be used to predict the movement of missiles, chemical/biological threats, and obscurant clouds. Synthetic atmospheric effects can be superimposed on electro-optical scenes for hardware-in-the-loop stimulation and human-in-the-loop simulation, or to influence the signal transmission/receiving performance in computer-based simulations of communication networks.**



**FLIR View**





# *STEP Concept*

**DoD initiated the Simulation Test and Evaluation Process to integrate M&S with T&E to improve the acquisition process.**

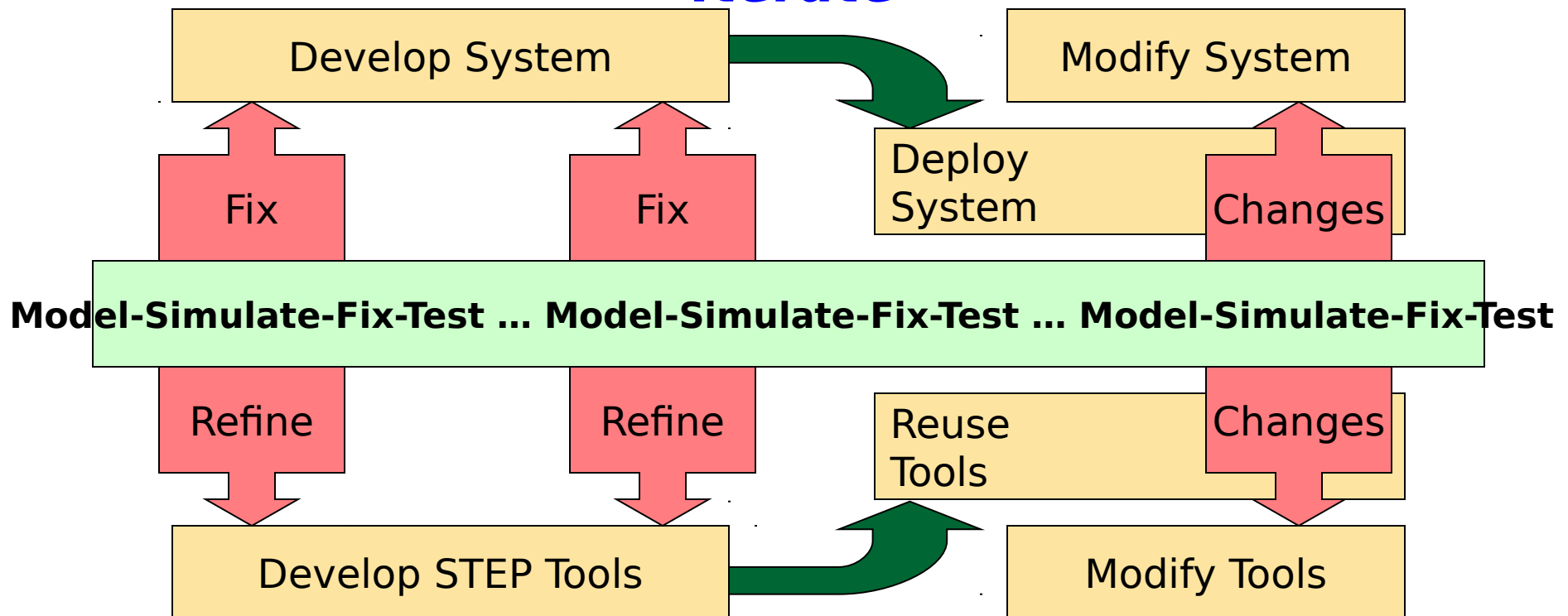
- ~~An iterative model-test-model process.~~
- Use M&S to provide predictions of system performance and effectiveness.
- Use test results (empirical or “ground truth” data) to refine and validate models and simulations.
- Implies iterative VV&A.
- Facilitates IPPD

*A byproduct of this process is a set of models and simulations with a known degree of credibility and potential reuse.*



# STEP Approach

## Model-Simulate-Fix-Test-Iterate





# *STEP in Army T&E*

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## **AR 73-1 Chapter 3**

- ***SMART is the Army's implementation of STEP.***
- Testing helps validate system models, which are executed in synthetic environments to support the decision-making process. *SMART tenets 1 & 2*
- Tested system models should be the same as, or traceable to, models used for concept development, analysis of alternatives, system design, and production. *SMART tenets 1 & 3*
- Synthetic test environments may also be reused for training, operations planning and rehearsal, and subsequent concept developments. *SMART Tenet 4*



# *Verification, Validation and Accreditation (VV&A)*

- **Verification**: The process of determining that a model implementation and its associated data *accurately represents the developer's conceptual description and specifications*.
- **Validation**: The process of determining the degree to which a model and its associated data are an *accurate representation of the real world* from the perspective of the intended uses of the model.
- **Accreditation**: Official certification that a model, simulation, or federation of models and simulations and its associated data are *acceptable for use for a specific purpose*.

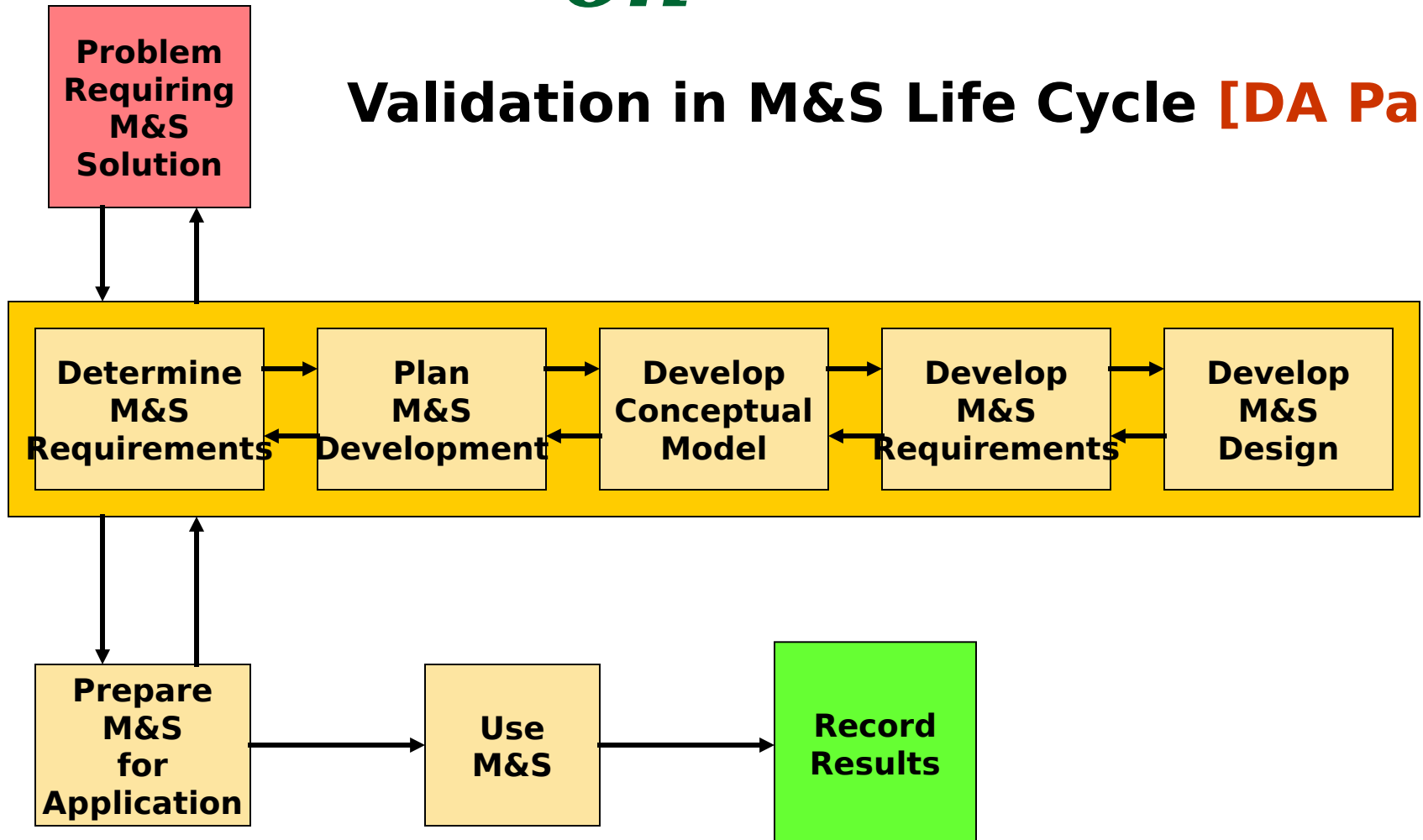
**DoDI 5000.61, DoD M&S VV&A**, applies to:

- *All mod and sims developed, used, or managed by the DoD Components.*
- *Models and simulations used in support of OT&E.*



# Validati on

## Validation in M&S Life Cycle [DA Pam .





# *Accreditation for* *T&E*

*Whenever models and simulations are to be used: identify the planned models and simulations; explain how they are proposed to be used; and provide the source and methodology of the verification, validation, and accreditation underlying their credible application for the proposed use. [DoD 5000.2-R]*

**CG, USATEC will conduct and/or support the verification, validation, and accreditation (VV&A) of all M&S used in T&E and accredit the M&S that are used to support assigned system evaluation. [AR 73-1]**

*Accreditation is the official determination by the M&S application sponsor that a model, simulation, or federation of M&S is acceptable for a specific purpose. [DA Pam 5-11]*



# VV&A Considerations

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***“Level of effort required to VV&A a model or sim”***

- ***Analysis, engineering, test, and training may require different levels of effort.***

***“How much VV&A is enough?”***

- ***VV&A cost vs risk of using M&S***
- ***Multiple use (reuse) of models and simulations require multiple validations and accreditations.***



# ***VV&A in SMART Context***

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***KEY: M&S IPT, T&E IPT and AST cross-flow***

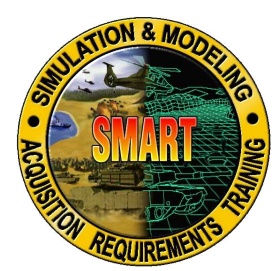
- ***Collaborate on development of models and simulations that can support multiple purposes***

- ***T&E representation on ICTs and M&S IPTs***

- ***All functional disciplines work from the same design database***

- ***Collaborate on Validation and Accreditation of M&S***

- ***Reuse of models across domains and phases***



# AGENDA - Section

## Threat

- Introduction, M&S Basics, SMART
- Policy & Guidance
- Simulation Support Plans
- Applying SMART in T&E
- *Lessons Learned*
  - *Lessons Learned Initiative*
  - *Key Lessons & Best Practices*
- Resources and Information





# *Lessons Learned Initiative*

## ■ **SMART Lessons Learned Initiative**

- Collect, analyze and distribute SMART lessons learned to improve the acquisition, requirements and training communities' awareness and understanding of modeling and simulation and the SMART concept.
- Create a learning environment that will improve SMART processes across all domains, integrating common initiatives.

## ■ **Army SMARTeam**

- Comprised of core members from PEO STRI, AMSO, and TRADOC, and supported by a pool of advisors from various Army organizations as required.
- Captures Lessons Learned by Army programs that have implemented SMART and application of M&S.



# *SMART Lessons Learned*

- **4 Lessons Learned (LL) events**

- ★ Aerial Common Sensor (ACS), May 03
- ★ Advanced Threat Infrared Countermeasure/Common Missile Warning System (ATIRCM/CMWS), Jul 03
- ★ Joint Common Missile (JCM), Jul 03
- ★ Rotary Wing (Apache, Comanche, Blackhawk, Chinook), May 04

- **Key Lessons Learned**

- Establish an *M&S IPT* (Comanche)
- Mapping ORD/CDD/CPD *KPPs* to models and simulations is a crucial step in determining how a program can benefit from M&S. (JTRS Cluster 1)
- Use KPPs and risk areas to *focus M&S efforts*. (ACS)
- *A formal process* facilitated understanding and analysis of how M&S could be successfully applied in the program and resulted in an executable M&S strategy. (JTRS Cluster 1)



# *Best Practices*

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1. Mapping ORD/CDD/CPD KPPs to models and simulations is a crucial initial step in determining how a program can benefit from M&S. (JTRS CI1)
2. Use Key Performance Parameters and risk areas to focus M&S efforts. (ACS)
3. *Ensure close collaboration between M&S developers and system testers & evaluators during model and simulation development and VV&A planning.* (ATIRCM, JCM)
4. Using a formal process facilitated understanding and analyzing how to apply M&S in the program and resulted in an executable M&S strategy. (JTRS CI1)
5. Collaborate with RDECs to leverage expertise and assets. (JCM)



# *Best Practices*

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6. *Determine model data requirements/sources early.* (JCM)
7. Identify opportunities to develop/reuse/leverage models and simulations that can *support test and training events, concurrently* if combined test and training events are planned. (IMASE)
8. Use incentives to foster collaboration with contractors during down select. (ACS)
9. *Plan for the orderly transition from modeled to operational SW and HW as testing & evaluation evolves.* (ATIRCM)
10. Creating, documenting and executing an M&S strategy that supports a contractor down-select decision requires clear communication of that strategy and early coordination and collaboration of effort among key system stakeholders. (WIN-T)



# *AGENDA - Section*

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## *Three*

- Introduction
- M&S Basics
- Policy &, Guidance
- SMART
- Simulation Support Plans
- Applying SMART principles
- Lessons Learned
- *Resources and Information*
  - *SMART Assistance*
  - *SMART Website*
  - *SMARTeam*





# *SMART*

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## *Assistance*

### ➤ **AMSO**

- Reviews program SSPs – comments to PM/IPT
- SMART policy & guidance – SMART website

### ➤ **Requirements Integration Working Group (RIWG)**

- Established by Army M&S Executive Council (AMSEC)
- Vets SSPs with Army M&S SMEs and organizations
- Provides comments/recommendations to PMs

### ➤ **Army SMARTeam (PEO STRI, AMSO, TRADOC)**

- Assist PMs with implementing SMART and SSPs



# *SMART*

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## *Website*

- Information on **SMART** (briefings, tutorials, conference info)
- Latest policy/guidance concerning SMART & SSPs – formal and informal
- Practical information about **SSPs** (guidance & examples)
- How to get help (request form & e-mail address)
- Sample SSPs
  - Available Now: **Warfighter Information Network – Tactical (WIN-T)**
  - Available Soon: **Modernized Apache Longbow Block III**
- FAQ's – Coming Soon

**SMART Website:** [www.amso.army.mil/SMART](http://www.amso.army.mil/SMART)  
**SMART POC:** [AMSO-SMART@hqda.army.mil](mailto:AMSO-SMART@hqda.army.mil)



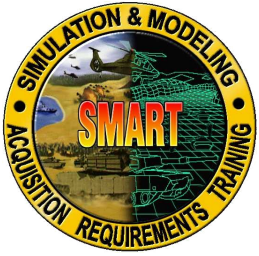
# SMARTea



***The Army SMARTeam provides SMART Contact Team Assis***

- ***Information, recommendations, and technical assistance*** to programs and projects about simulation support planning and implementing SMART.
- ***How to apply M&S*** throughout the acquisition life cycle to reduce risk and costs and accelerate traditional acquisition processes.
- ***Information about models and simulations*** that could be reused or adapted, and SMART Lessons Learned and Best Practices.
- ***Advice on developing*** SSPs, M&S tools, models and simulations, simulation environments and advanced collaborative environments.
- SMART Contact Team **customers** include TRADOC ICTs, PMs, ATDs, Army led ACTDs, STOs and others

**email: [smarteam@peostri.army.mil](mailto:smarteam@peostri.army.mil)**



# SMARTea



-----Original Message-----

From: Cole, COL Thomas PM WIN-T

Sent: Monday, February 16, 2004 5:55 PM

To: Rider, Mark D COL SAALT

Subject: Note to COL Rider

Mark,

On 12 Feb I had the pleasure of receiving a very informative out-brief from your SMARTeam who had traveled to Ft Monmouth to assist the WIN-T modeling and simulation effort. The SMARTeam consisted of the following members and organizations:

Becky Shell

PEO STRI

Jim Wallace           AMSO

Michelle Bevan       AMSO

Barbara Pemberton   PEO STRI

MAJ Bryon Hartzog   TRADOC/ATSC

I wanted to send a note to personally thank you for the SMARTeam support we received. The three day site visit was very productive for my staff and the WIN-T program. Your team members were well prepared, ready to work, and displayed a genuine desire to assist in producing a quality Simulation Support Plan and M&S plan. WIN-T is the Army's future single integrating network and our modeling and simulation effort is critical to meeting program performance and schedule objectives.

We have tentatively scheduled follow-up support in the upcoming weeks and look forward to your continued support from your capable team.

Best Regards,

COL Tom Cole

PM WIN-T

30 August 2004

**... "thank you for the SMARTeam support we received. The three day site visit was very productive for my staff and the WIN-T program. Your team members were well prepared, ready to work, and displayed a genuine desire to assist in producing a quality Simulation Support Plan and M&S plan."**